Multi-Dimensional Imaging Systems

Breakout Group 3

Camera AB Initio Workshop

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Multidimensional Imaging

Possible choices:

x,y,z, wavelength, polarization, temporal …. (acoustic, olfactory)

Desired system attributes:

Adaptive

Predetection ‘processing’ (measure features where possible, not pixels)

Network - fine grain and coarse grain

Compact

Passive and Active modalities

Machine can be consumer of data (imaging or non-imaging)

System geometry

Must answer “What? and Where?”

Solution before the problem?

First we explored applications that might benefit from multidimensional data. Wide ranging discussions:

Examples: create terrain maps, tank in foliage, ATR,

Comment: very specific tasks will yield unconventional designs

How is multidimensional done now?

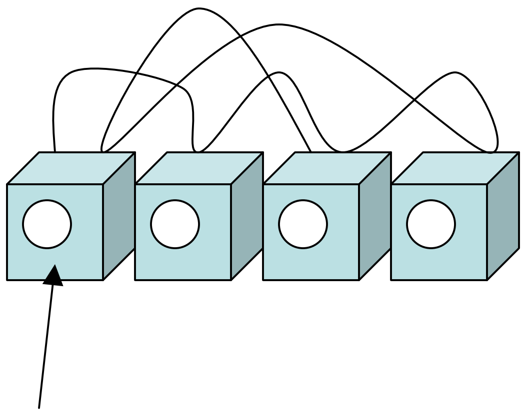
- Acquire as large of a cube as possible and start processing.

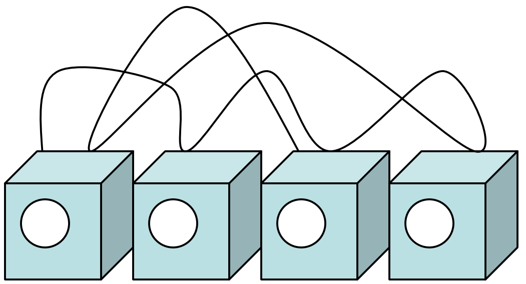
‘Ideal’ alternative - adaptive system with variable ‘g-resolution’ in all dimensions.

G-resolution= generalized resolution= ‘more than binning’ ability to optically sum weighted measurements with no adjacency requirement

How to exploit such a sensor?
-start coarse and refine
-Use starting point based on a priori information

Adaptivity mechanisms:





Adaptivity within each 'subsensor'

Adaptive networking

Or multiple cheap sensors each with different settings (e.g. FOV)

Or both

Adaptive variable resolution systems:

X,y,z:

Several 2d imagers each with variable focal length lenses for focus adjust / zoom (large index change optics – Buckley)

Some with extended depth wavefront coding

Some with ultra narrow depth (possibly adaptive wavefront coding – new MEMS)

Several 2d imagers on complicated surface – use geometry self calibration …

Adaptive Wavelength Emitting Sensor based on Optical Modular Elements (AWESOME)

Receiver and Illuminator are distinct modules combined in LEGO fashion.

- A large array of illuminators versus an interleaved array would be two different systems
- Modules: Optics (active / passive), Emitter, Receiver, INU, GPS

Computation

- On array processing
- Distributed among nodes

Advantages of the array:

- Adaptive Foveation
- Robustness
- Graceful degradation
- Stealthiness

Adaptive Wavelength Emitting Sensor based on Optical Modular Elements (AWESOME)

Emitter properties:

- VCSEL Array
- Tunable (wavelength, polarization)
- High speed modulation (10GHz)
- Beam steering
- Phase locked with phase adjustment between emitters

Receiver properties:

- Pixels or groups of pixels phase locked to emitters
- Tunable (spectrum and polarization)
- Randomly addressable pixels
- Binning / convolutions / general purpose computations at the pixel level and groups of pixels.

Adaptive Wavelength Emitting Sensor based on Optical Modular Elements (AWESOME)

Challenges:

- Find \$100M
- Large amounts of data can be produced
- How to optimize the the local and global processing
- Optimize communication at the local and global level
- Self calibration
- VCSEL construction
- Optics: ultra large FOV sensing
- FPA construction
- Non-commutative harmonic analysis (In the space of light rays)